National Climatic Data Center

DATA DOCUMENTATION

FOR

DATA SET 3286 (DSI-3286)

Climate Reference Network

March 19, 2003

National Climatic Data Center
151 Patton Ave.
Asheville, NC 28801-5001 USA

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Table of Contents

1. Abstract: This data set contains hourly observations that are measured at sites specifically located for their representation of the climate of the United States. Observations are made by an automated instrument package, transmitted to a GOES satellite which in turn transmits the data to Wallops Island, Va. NCDC retrieves the data from Wallops Island using Local Readout Ground Station (LRGS) software. Wallops Island also sends the CRN data to the National Weather Service Telecommunications Gateway (NWSTG) who posts the data on the NWS Gateway. NCDC has retrieved the data using an ftp process since 2001.

Variables to be Measured

Several climate system variables were identified by the National Research Council as relevant to the detection, attribution, and direct societal impacts of climate change. The surface atmospheric variables include: air temperature, humidity, wind, radiative (skin) temperature, sea level pressure, precipitation, snow cover extent, snowfall, snow water equivalent, sea ice, fluxes of sensible and latent heat, fluxes of atmospheric trace gases and particulate material, incident solar radiation and downward longwave radiation, albedo, streamflow and reservoir volume, groundwater, and vegetative cover.

The NRC report assigned the highest overall ranks to the traditionally measured variables temperature and precipitation. Therefore, in response to the NRC ranking, each CRN station will measure temperature and precipitation. In addition, wind speed at thermometer height and solar radiation will be measured to establish rigorous transfer functions relating the CRN measurements to historical temperature data recorded at nearby stations in other networks that have long-term records. These transfer functions will be based partially on studies conducted by Lin and Hubbard (1999) and Guttman and Baker (1996). Soil moisture and soil temperature will be measured using sensors provided by the USDA.

Every station will be equipped with this standard set of core sensors attached to a 10-foot (3-meter) mast and include the capability to add supplementary sensors in the future. "Off-the-shelf" commercially-available sensors will be selected based on performance, durability, and cost.

2. Element Names and Definitions:

Special Notes

Temperature:

The Platinum Resistance Thermometer (PRT) is a precision temperature sensor. CRN stations transmit seven values for each of the three temperature sensors (21 total values): Hourly average temperature, hourly max and min temperatures and the time of their occurrence, standard deviation and five-minute average temperature for the last five-minute period in the hour (NWS request).

Because solar heating of the temperature sensor can lead to errors of near 2 C in calm wind in an unventilated radiation shield, the sensor must be aspirated to achieve high accuracy in temperature. An aspirating fan must produce a flow rate of 2.5 to 10 m/s.

An example of an aspirated radiation shield is that designed by R. M. Young. It draws 500 mA at 12 vdc so that a 55 A-h battery should run 4 days w/o recharge. These shields are expensive, as are the blowers. If platinum resistance thermometers are used also, the cost of having two complete independent temperature measurement systems may be cost prohibitive for the

total network. However, pairs of independent measurements should be made during the validation phase.

Sensor will be placed at NWS & WMO standard height of 1.5 meters (5 feet).

Wiring specifications: minimize heat conduction, proper grounding and shielding.

Each station will have two aspirated thermometers. Each sensor will be located at the end of an arm extending from a 3 meter (10 foot) mast. One thermometer will serve as a backup for the other. In practice, if the two thermometers systematically differ by more than 0.2 C, remedial action will be taken. The problem may be a sensor, an aspirator motor, airflow blockage, or result from some other cause. Solving the problem will require a technician to travel to the site to perform an independent measurement of temperature at the same height as the station sensors. The results of a few hours comparison under appropriate conditions usually will be sufficient to indicate the source of the problem and what to do about it. Spare calibrated sensors and aspirator motors must be part of the equipment brought to the station.

In the first implementation of about 6 stations, at least 3 aspirated temperature sensors will be used for each station. The purpose is to show whether it is possible to isolate the specific temperature sensor that is defective using the 0.2 C criterion. A trade-off may occur between the cost of adding a third thermometer and the likelihood of sensor degradation.

Precipitation:

There are two issues in selecting gauges. One is that we need to find a way to reasonably accurately measure snow (i.e., liquid water equivalent). The other is measuring high rain rates. The T-200B precipitation gauge is designed for year round remote automatic measurements of accumulated precipitation as well as precipitation intensity. The gauge consists of a protective housing with an inlet for precipitation with a container for collecting snow/rain. The amount of precipitation is monitored by a weighing sensor. Measurement of snow requires a heated weighing gauge with wind screens. Values transmitted are the hourly average, maximum and minimum frequencies, the calculated precipitation for 0-15, 15-30, 30-45 and 45-60 minutes, and the hourly total and the calculated precipitation level at the end of each 15 minute period.

Gauge heating is likely best done using AC as opposed to DC power. During the period when gauge heating is needed, the likelihood of lighting strikes producing power surges is small. The AC line can be disconnected in the warm season.

High rain rates can be measured using either tipping-bucket (TB) or weighing-bucket (WB) gauges. In the case of TB gauges there is an undercatch due to loss of water during time of tip which can be substantial in high rain rates (McKee *et al.*, 1995 and 1996). For example, with a rainfall rate of 200 mmh^{-1}, the undercatch can be 10 to 15%. To account for this a 2^{nd} degree correction can be used. However, determination of the 2^{nd} degree coefficient is time consuming and laborious, and there is some question about repeatability of the coefficient. On the other hand, calibration for a WB gauge is comparatively simple in that a set of known weights can be introduced (corresponding to a set of water depths) and the associated output recorded. The downside is that there can be noise due to wind pumping and thermal effects. (We will measure precipitation amounts for every minute to smooth these sampling [error] effects due to wind pumping; consequently, we do not want an intelligent gauge.)

Laboratory accuracy will be evaluated by using known weights. Environmental accuracy will be evaluated by comparing against the National Weather Service 8-inch gauge with Wyoming (or double Alter) shield.

The problem of undercatch in precipitation gauges (Groisman and Legates, 1994), resulting from wind-induced turbulence at the gauge orifice and wetting losses on the internal walls of the gauge, can seriously affect the utility of precipitation data for climate change studies. This can seriously affect the accurate measurement of snowfall. The higher the wind speed the greater the undercatch. There are a number of ways to reduce the "wind effect", including the use of one or more wind shields (WMO, 1996). A field experiment is being carried out at the National Center for Atmospheric Research (NCAR) and funded by CRN to investigate the use of 3 concentric wind shields or fences to significantly reduce snow undercatch. The 3-fence combination is based on the WMO Double Fence Intercomparison Reference (DFIR). The wind shield version that will be used in the CRN is smaller in diameter and has an Alter shield as the innermost fence.

If the vendor recommends using an antifreeze solution, we are concerned about (1) how they will dispose of the antifreeze in an environmentally-safe manner and (2) how much that will cost.

Wind Speed:

Wind speed is measured, along with solar radiation and ground surface (skin) temperature, to provide information to allow for correction of observed air temperature data due to solar heating. Wind speed will also be useful in interpreting the “catch” of the precipitation gauge(s), which may be affected by aerodynamics or other factors related to the wind speed.

Wind speed will be measured with a cup anemometer that generates a square-wave or pulse frequency proportional to wind speed. The anemometer will be mounted at the end of an arm extending outward from the tower at a height of 1.5 m in the direction that minimizes tower interference due to the wind based on climatology. The main cause of degraded wind speed is bearing-wear. A comparison to a standard anemometer will be made during each site visit.

Values included within the transmission are the average hourly wind speed and the standard deviation. Range includes 0 to 60 meters per second with a starting speed of approximately 0.5 meters per second.

Solar Radiation:

Solar radiation is measured, along with wind speed and ground surface (skin) temperature, to provide information to allow for correction of observed air temperature data due to solar heating. A Kipp & Zonen SP Lite Pyranometer measures solar radiation at each station. The datalogger samples the sensor every two seconds. Every five minutes these two-second samples are averaged to obtain 5-minute values.

The SP Lite is a silicon pyranometer that measures solar radiation from the entire hemisphere. The sensor consists of a photodiode shunted by a resistor, housing and cable.

FORMAT (VARIABLE RECORD):

The first eleven data fields, the ID PORTION of the record, describe the characteristics of the entire record. The DATA PORTION of the record contains :

information about each element value reported. This portion is repeated for as many hourly values as occur in a day.

Each logical record is of variable length with a maximum of 374 characters. Each logical record contains a site's hourly data for a specific element for a one day interval.

List of Variables

ELEMENT	WIDTH	POSITION	
001 RECORD TYPE	3	001-003	I
002 STATION I.D.	8	004-011	D
003 GOES I.D.	8	012-019	
004 METEOROLOGICAL ELEMENT TYPE	4	020-023	
005 MET. ELEMENT MEASUREMENT UNIT CODE	2	024-025	P
006 YEAR	4	026-029	O
007 MONTH	2	030-031	R
008 SOURCE CODE 1	1	032	T
009 SOURCE CODE 2	1	033	I
010 DAY OF MONTH	2	034-035	O
011 NUMBER OF DATA PORTION GROUPS THAT FOLLOW	3	036-038	N
012 TIME OF OBSERVATION (HOUR)	4	039-042	
013 SIGN OF METEOROLOGICAL VALUE	1	043	D
014 VALUE OF METEOROLOGICAL ELEMENT	7	044-050	A
015 QUALITY CONTROL FLAG 1	1	051	T
016 QUALITY CONTROL FLAG 2	1	052	A
(017-021) DATA GROUPS IN THE SAME FORM AS TAPE	14	(053-066)	P
(022-026) FIELDS O11-015. REPEATED AS MANY TIMES	14	(067-080)	O R
(027-031) AS NEEDED TO CONTAIN ONE DAY OF RECORD.	14	(081-094)	T I
(126-131)	14	(361-374)	O N

ID PORTION (30 Characters) Variable Length

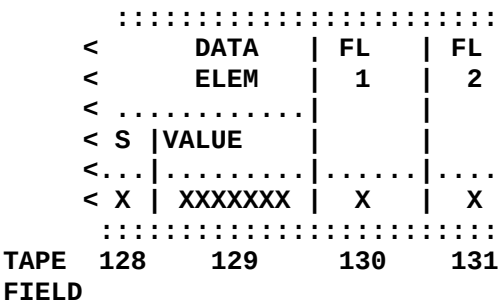
REC TYP	STATION ID	GOES ID	ELEM TYPE	UNT	YEAR	MO	SRC 1	SRC 2	DAY	NO. VAL.
XXX	XXXXXXXX	XXXXXXXX	XXXX	XX	XXXX	XX	X	X	XXX	XXX

TAPE FIELD 001 002 003 004 005 006 007 008 009 010 011

DATA PORTION (14 Characters Number-Values Times)

TIME HOUR	DATA ELEM	FL 1	FL 2	TIME HOUR	DATA ELEM
	S VALUE				S VALUE
XXXX	X XXXXXXX	X	X	XXXX	X XXXXXXX

TAPE 012 013 014 015 016 017 018 019
FIELD



TAPE 128 129 130 131
FIELD

RECORD TYPE
The type of data stored in this record. (Value is "CRN"). Each record contains one day of hourly values.

STATION-ID
Contains the WBAN Station Number. (Assigned by NCDC.) ID Range of values = 00000000-00099999. Five digit station numbers are always right justified and zero filled.

GOES-ID
Contains the GOES Identification Number. (Assigned by NESDIS Data Collection Program (DCP)Office.) The GOES ID number is an eight digit alpha_numeric identifier. The GOES ID numbers specific to the CRN sites all begin with a unique two letter designation “CD” which identify the site as a CRN site.

ELEMENT-TYPE
The type of element stored in this record consisting of a four character alphanumeric code. Range of values is listed below.

AWND
DESCRIPTION: Wind Speed average for hour
VALID TIMES: Through current
COMMENTS:

AWSD
DESCRIPTION: Wind Speed standard deviation
VALID TIMES: Through current
COMMENTS:

BTVL
DESCRIPTION: Battery voltage for fan and GOES transmitter battery
VALID TIMES: Through current
COMMENTS:

BVDL
DESCRIPTION: Battery voltage for CR23X datalogger
VALID TIMES: Through current
COMMENTS:

BVFL
DESCRIPTION: Battery voltage for fan and GOES
VALID TIMES: Through current
COMMENTS:

CVER
DESCRIPTION: CR23X program version number
VALID TIMES: Through current
COMMENTS:

FSP1
DESCRIPTION: Fan speed output for aspirated shield for temperature sensor #1
VALID TIMES: Through current
COMMENTS:

FSP2
DESCRIPTION: Fan speed output for aspirated shield for temperature sensor #2
VALID TIMES: Through current
COMMENTS:

FSP3
DESCRIPTION: Fan speed output for aspirated shield for temperature sensor #3
VALID TIMES: Through current
COMMENTS:

OPDT
DESCRIPTION: Time in minutes during the past hour that the enclosure door was open.
VALID TIMES: Through current
COMMENTS:

PAFQ
DESCRIPTION: Hour rain gage frequency average
VALID TIMES: Through current
COMMENTS:

PNFQ
DESCRIPTION: Hour rain gage frequency minimum
VALID TIMES: Through current
COMMENTS:

PXFQ
DESCRIPTION: Hour rain gage frequency maximum
VALID TIMES: Through current
COMMENTS:

PCP1
DESCRIPTION: Precipitation 0 to 15 minutes of hour
VALID TIMES: Through current
COMMENTS:

PCP2
DESCRIPTION: Precipitation 16 to 30 minutes of hour

VALID TIMES: Through current
COMMENTS:

PCP3
DESCRIPTION: Precipitation 31 to 45 minutes of hour
VALID TIMES: Through current
COMMENTS:

PCP4
DESCRIPTION: Precipitation 46 to 60 minutes of hour
VALID TIMES: Through current
COMMENTS:

PCPT
DESCRIPTION: Precipitation total for hour
VALID TIMES: Through current
COMMENTS:

RHAV
DESCRIPTION: RH probe RH hourly average
VALID TIMES: Through current
COMMENTS:

RHSD
DESCRIPTION: RH probe standard deviation
VALID TIMES: Through current
COMMENTS:

SFTP
DESCRIPTION: Surface Temperature
VALID TIMES: Through current
COMMENTS:

STSD
DESCRIPTION: Surface Temperature standard deviation
VALID TIMES: Through current
COMMENTS:

SOLR
DESCRIPTION: Solar Radiation
VALID TIMES: Through current
COMMENTS:

SLSD
DESCRIPTION: Solar Radiation standard deviation
VALID TIMES: Through current
COMMENTS:

T1AV
DESCRIPTION: Temperature sensor #1 hourly average
VALID TIMES: Through current
COMMENTS:

T1SD
DESCRIPTION: Temperature sensor #1 standard deviation
VALID TIMES: Through current

COMMENTS:

T2AV
DESCRIPTION: Temperature sensor #2 hourly average
VALID TIMES: Through current
COMMENTS:

T2SD
DESCRIPTION: Temperature sensor #2 standard deviation
VALID TIMES: Through current
COMMENTS:

T3AV
DESCRIPTION: Temperature sensor #3 hourly average
VALID TIMES: Through current
COMMENTS:

T3SD
DESCRIPTION: Temperature sensor #3 standard deviation
VALID TIMES: Through current
COMMENTS:

T1HR
DESCRIPTION: Average Temperature for sensor 1, minutes 55 to 60
VALID TIMES: Through current
COMMENTS:

T2HR
DESCRIPTION: Average Temperature for sensor 2, minutes 55 to 60
VALID TIMES: Through current
COMMENTS:

T3HR
DESCRIPTION: Average Temperature for sensor 3, minutes 55 to 60
VALID TIMES: Through current
COMMENTS:

T1MN
DESCRIPTION: Temperature sensor #1 hour minimum
VALID TIMES: Through current
COMMENTS:

T1NT
DESCRIPTION: Temperature sensor #1 hour minimum time of occurrence
VALID TIMES: Through current
COMMENTS:

T2MN
DESCRIPTION: Temperature sensor #2 hour minimum
VALID TIMES: Through current
COMMENTS:

T2NT
DESCRIPTION: Temperature sensor #2 hour minimum time of occurrence
VALID TIMES: Through current
COMMENTS:

T3MN
DESCRIPTION: Temperature sensor #3 hour minimum
VALID TIMES: Through current
COMMENTS:

T3NT
DESCRIPTION: Temperature sensor #3 hour minimum time of occurrence
VALID TIMES: Through current
COMMENTS:

T1MX
DESCRIPTION: Temperature sensor #1 hour maximum
VALID TIMES: Through current
COMMENTS:

T1XT
DESCRIPTION: Temperature sensor #1 hour maximum time of occurrence
VALID TIMES: Through current
COMMENTS:

T2MX
DESCRIPTION: Temperature sensor #2 hour maximum
VALID TIMES: Through current
COMMENTS:

T2XT
DESCRIPTION: Temperature sensor #2 hour maximum time of occurrence
VALID TIMES: Through current
COMMENTS:

T3XT
DESCRIPTION: Temperature sensor #3 hour maximum time of occurrence
VALID TIMES: Through current
COMMENTS:

T3MX
DESCRIPTION: Temperature sensor #3 hour maximum
VALID TIMES: Through current
COMMENTS:

TPRH
DESCRIPTION: RH probe Temperature hourly average
VALID TIMES: Through current
COMMENTS:

TRSD
DESCRIPTION: RH probe Temperature standard deviation
VALID TIMES: Through current
COMMENTS:

ELEMENT - UNITS
All elements have been multiplied by 1000 so the decimal position may be found by dividing the element by 1000.

DC - Degrees Celsius

H - Hertz
HR - Hours and minutes
M - Millimeters
MH - Miles per Hour
MN - Minutes of the hour
MS - Meters per Second
NA - No units Applicable
P - Percent
RS - Revolutions per Second
V - Volts
WH - Watt Hours per meter squared

NOTE: All entries are left justified and blank filled.

YEAR
This is the year of the record. Range of value is 2001 to the current year processed.

MONTH
This is the month of record. Range of value is 01-12.

SOURCE CODE-1
Contains a code indicating the primary source of the original record this element was taken from. Range is 1-9.

SOURCE CODE TABLE

1	LRGS
2	NOAAPORT CHANNEL 4
3	PROCOMM TELNET CAPTURE

Source codes reflect normally expected data sources and do not necessarily indicate the actual source of a specific item.

SOURCE CODE-2
Contains a code indicating the back-up source of the original record this element was taken from. Range is 1-9.

SOURCE CODE TABLE

1	LRGS
2	NOAAPORT CHANNEL 4
3	PROCOMM TELNET CAPTURE

DAY
Contains the day of the record. Range 01-31.

NUM-VALUES
This notates the actual number of values reported. Range of values is 001-024.

NOTE: A record may contain fewer data values than you might expect. A daily record of hourly values may contain as few as one data value or as many as 24. This is due to missing data. If a particular data value was unavailable there is no entry for it.

TIME-OF VALUE
Contains the hour and minute of the hourly element value. Range is 0000-2300. The hour is in the leftmost two digits and the minute is in the rightmost two digits. Minutes are always 00. Hour is reported using the 24 hour clock. Observation times are in Local Standard Time.

SIGN OF METEOROLOGICAL VALUE
This is the 'SIGN' of the meteorological data value. This field contains either

1) a plus indicating a positive value, or zero,
2) a minus sign indicating a negative value.

DATA- VALUE
Actual data value. This field is a seven-digit integer. Unit and decimal position of the data value are indicated in the ELEMENT-UNITS field described in Data Field 004.

FLAG-1
The data measurement FLAG.
b - (blank) No flag values assigned.

FLAG-2
The data quality FLAG.
0 - Good Value. No known problems.
1 - Failure. The data value corresponds to a sensor/instrument/equipment failure.
2 - Bad Value. Data fails automated QC.
3 - Suspect Value. Data falls outside instrument limits.
4 – Data logger door open. The instrument suite data logger door was opened.

3. Start Date: 20011001

4. Stop Date: Ongoing.

5. Coverage: Continental US

a. Southernmost Latitude: 25S
b. Northernmost Latitude: 50N
c. Westernmost Longitude: -125W
d. Easternmost Longitude: -65E

6. How to Order Data:

Ask NCDC's Climate Services about the cost of obtaining this data set.
Phone: 828-271-4800
FAX: 828-271-4876
E-mail: **NCDC.Orders@noaa.gov**

7. Archiving Data Center:

National Climatic Data Center
Federal Building

151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

8. Technical Contact:

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

9. Known Uncorrected Problems: None.

10. Quality Statement: Quality of the Climate Reference Network data is considered quite good. All observations have received quality control measures.

11. Essential Companion Datasets: None.

12. References: None provided with original documentation.